Wound-rotor transformer and power source device using said wound-rotor transformer

BACKGROUND OF THE INVENTION:

The present invention relates to output transformer for wound- rotor high tension of plural output type to be used in inverters for driving loads such as cold cathode fluorescent lamps and the like and power source device using said wound-rotor output transformers for high tension.

Heretofore, a transformer (for example, refer to Japanese official gazette, Japanese Patent Kokai 2002-07575) is known wherein a plurality of mid leg portion and separate wall portion and external wall portion are formed at least one part of a set of cores forming a closed magnetic circuit, and separate secondary windings are mounted concentrically on each of the mid leg portion, and a primary winding is mounted on the inside of the outer peripheral wall portion to enclose the whole secondary windings thereby exciting the plural secondary windings simultaneously by one primary winding.

Furthermore, as illustrated in FIG. 16, in case of driving cold cathode fluorescent lamp 46 with output of the wound-rotor transformer, heretofore, an electrode of the fluorescent lamp 46 is connected to a high tension terminal of the winding of the secondary side of a wound-rotor transformer T by means of a capacitor, and the capacitor and the other electrode of the

fluorescent lamp 46 is connected to the earth by means of a resistor. Furthermore, in case of driving four pieces of the fluorescent lamps, as shown in FIG. 17, wound-rotor transformers T1, T2, T3 and T4 are prepared, and two pieces of the fluorescent lamps 46, 46 are connected in series, and among each pair of the fluorescent lamps, the fluorescent lamps 46, 46 of one part are connected to the secondary side high tension terminals of the corresponding wound-rotor transformers T1, T3 by means of a ballast capacitor, and the other part of the fluorescent lamps 44, 44 are connected to the secondary side high tension terminals of the corresponding wound-rotor transformers T2, T3 by means of a ballast capacitor, and the other terminals at the secondary side of each wound-rotor transformers T1, T2, T3, T4 is connected to the earth.

Furthermore, in ballastless discharge lamp lighting circuit using multilamp leakage transformers, a DC/AC inverter circuit (for example, refer to official gazette of Japanese Patent Kokai 2002-075756) is known in which both terminals of one part of the secondary winding are connected to both terminals of the discharge lamp by means of an earth wire, and the other secondary windings are connected to both terminals of another discharge lamp by means of the earth wire, and as a result, two discharge lamps are simultaneously driven by one input.

Heretofore, in the wound-rotor output transformers for high tension, and in case of constructing a plurality of output units at the secondary side, there has been problems that structure of

the core and arrangement of windings become complicated and large size structure.

An object of the present invention is to solve the foregoing problems.

Furthermore, in a system of driving fluorescent lamps by connecting one electrode of the fluorescent lamp (discharge lamp) to a high tension terminal at the secondary side of the wound-rotor transformer and connecting the other electrode to the earth wire, one terminal side of the fluorecent lamp becomes high tension, and the other terminal side becomes low tension thereby the transformer connected side turns to bright while the earth wire connected side turns to dark, and irregularity of luminance occurs which are points of problems. In a system of driving two pieces of fluorescent lamps with two pieces of wound-rotor transformers, high tension occurs at both terminals of two pieces of the fluorescent lamps, and thus, occurrence of generation of irregularity of brightness may be eliminated but a wound-rotor transformer is required for each of the fluorescent lamps which does not meet with miniaturization of the wound-rotor transformers which are points of problems.

The present invention aims to solve the foregoing problems.

SUMMARY OF THE INVENTION:

The present invention is constructed in such a way that a primary winding is mounted in a central portion of an insulator such as bobbin and the like, and a first and second secondary windings are mounted at both sides of this primary winding.

A lead wire of a terminal of the first secondary winding is connected to a secondary high tension terminal of a first terminal unit, and the lead wire of one terminal of the primary winding and the lead wire of one terminal of a winding at the side in contact with the primary winding of the first secondary winding are respectively connected to a primary input terminal and a ground terminal corresponding to the first terminal unit. The lead wire of one end of the second secondary winding is connected to the secondary high tension terminal of the second terminal unit, and the lead wire of another terminal of the primary winding and the lead wire of one end of the winding at the side in contact with the primary winding of the second secondary winding are connected to the primary input terminal corresponding to the second terminal unit and the ground terminal. A core is mounted on a bobbin (insulator) to construct a wound-rotor transformer having a plurality of outputs.

Furthermore, the present invention is to provide a power source device by providing a resonance circuit at primary side by connecting a resonance capacitor to the primary winding of the wound-rotor transformer, and connecting a self-commutating circuit that self commutates with resonance frequency at primary side on the basis of a feedback signal of the resonance voltage at primary side to the primary winding. It is possible to generate high tension at the primary side of the output circuit at the primary side of the output transformer and as a result, high tension can be obtained without increasing a number

of windings at the secondary side whereby a small size circuit of output transformer can be constructed.

Whereas the present invention is constructed in such a way that among two pieces of fluorescent lamps of the first and second fluorescent lamps, one electrode of the first fluorescent lamp is connected to a secondary high tension terminal of the first secondary winding, and the second fluorescent lamp is connected in series to the secondary high tension terminal of the second secondary winding.

DESCRIPTION OF DRAWINGS:

FIG. 1 shows a descriptive plan view of a wound-rotor transformer of the present invention.

FIG. 2 shows a plan of a shielding member.

FIG. 3 shows A-A cross sectional drawing.

FIG. 4 shows a side view of the wound-rotor transformer of the present invention.

FIG. 5 shows a cross sectional drawing of an important part of the wound-rotor transformer.

FIG. 6 shows a block circuit diagram showing an example of application of the present invention.

FIG. 7 shows an explanatory drawing of the present invention.

FIG. 8 shows an explanatory drawing showing another embodiment of the wound-rotor transformer.

FIG. 9 shows an explanatory drawing of an outside view showing another embodiment of the wound-rotor transformer.

FIG. 10 shows an explanatory drawing of an outside view

showing another embodiment of the wound-rotor transformer.

FIG. 11 shows an explanatory drawing of an outside view showing another embodiment of the wound-rotor transformer.

FIG. 12 shows an explanatory drawing showing another embodiment of the wound-rotor transformer.

FIG. 13 shows an explanatory drawing of an outside view showing another embodiment of the wound-rotor transformer.

FIG. 14 shows a decomposed explanatory drawing showing another embodiment of the wound-rotor transformer.

FIG. 15 shows a block circuit diagram showing another embodiment of the present invention.

FIG. 16 shows a circuit diagram of the conventional technology.

FIG. 17 shows a circuit diagram of the conventional technology.

DETAILED DESCRIPTION OF THE INVENTION:

The present invention will be described in detail with its embodiment by referring to the drawings.

In FIG. 1, numeral 2 denotes a bobbin (insulator) of a wound-rotor transformer 44, and a plurality of partitions 4, 6, 8, 10 12, 14 of square plate type for insulation and pressure resistance are provided with a predetermined interval at its angular cylindrical part, and terminal units 16, 18 extending in right angle direction relative to an axial direction of the bobbin (insulator) are fixed at both ends in the axial direction of the bobbin (insulator) 2, and

terminals 20, 22, 24, 26, 28, 30 are fixed to the bobbin.

A secondary high tension terminal 24 is disposed on the terminal unit 16 in its one side, said terminal unit 16 being at one end side of the bobbin (insulator) 2, and a primary input terminal 22 and a secondary ground terminal 20 are disposed at the other side. The primary input terminal 22 and the ground terminal 20 are disposed at the other side of the terminal unit 16 so that those terminals are not under influence of high tension of the secondary high tension terminal 24 by keeping them apart as much as possible. On the terminal unit 18 at the other side of the bobbin (insulator) 2, a secondary high tension terminal 30 is disposed at the one side, and the primary input terminal 28 and the secondary ground terminal 26 are disposed at the other side which are kept away from them as much as possible. An shelter 34 made of elongate insulation material is mounted in guide mounting grooves 16a, 18a formed at the mounting side of the terminal 20. 22 and 26, 28 of the terminal units 16, 18. and a concave portion 34b of the shelter 34 fits an external edges of the corresponding partitions 4, 6, 8, 10, 12, 14. On the insulator 34, a lead wire guide portion 34a formed by a groove open to the opposite side from the side facing the bobbin (insulator) 2 along its longitudinal direction.

In the concave portion surrounded by the partitions 8, 10 at center of the bobbin (insulator) 2, with one end side A as the start of winding, the primary winding 32 is, for example, wound in clockwise direction. The lead wire 32a of the

winding start end of the primary winding 32 is disposed inside of a lead wire guide portion 4a of the shelter 34 through the hole 36 formed on the shelter 34 and is led to one end side of the bobbin (insulator) 2 through the lead wire guide portion 34a, and is connected to a primary side input terminal 22 by means of a guide groove formed on the terminal unit 16. The lead wire 32a of the last end side D of the primary winding 32 is disposed inside of the lead wire guide portion 34a of the shelter 34, and is led to the other other end side of the bobbin (insulator) 2 through the hole 38 formed on the shelter 34, and is led to the other end side of the bobbin (insulator) 2 through the lead wire guide portion 34a and is connected to the primary side input terminal 28 by means of the guide groove formed on the terminal unit 18. At one side of the primary winding 32 on the bobbin (insulator) 2, one end side B of the bobbin (insulator) 2 becomes a winding start, and a first secondary winding 39 is clockwise winding, and is sequentially wound around each concave portion between the terminal unit 16, and partition 4, partitions 4 and 6, and partitions 6 and 8.

The reason for dividing the mid portion of the secondary winding 39 with a plurality of partitions 4, 6 and 8 is to take a consideration of the insulation pressure resistance of the secondary winding 39. A lead wire 39a at the winding start end side B of the first secondary winding 39 is led to the secondary high tension terminal 24 through the groove formed by the terminal unit 16 and is connected thereto. A lead wire

39b at the winding end side C of the first secondary winding 39 is disposed in the lead wire guide portion 34a of the shelter 34 by means of the hole 36, and is led to one end side of the bobbin (insulator) 2 through the lead wire guide portion 34a together with the lead wire 32a, and is connected to the ground terminal 20 at the secondary side by means of the guide groove formed on the terminal unit 16. At the other side of the primary winding at the center of the bobbin (insulator) 2, the side D in contact with the partition 10 is the winding start, and the second secondary winding 41is clockwise winding, and is sequentially wound around each concave portion between the partitions 10 and 12, partitions 12 and 14, and partitions 14 and the terminal unit 18.

The first and second secondary windings 39 and 41 disposed symmetrically at right and left of the primary winding 32 are of an identical construction. A lead wire 41b at the last end side E of the second secondary winding is led to the secondary high tension terminal 30 through the groove formed by the terminal unit 18, and is connected thereto. A lead wire 41a at the winding start end side D of the second secondary winding 41 is disposed inside of the lead wire guide portion 34a of the shelter 34 by means of the hole 38, and is led to the other end side of the bobbin (insulator) 2 through the lead wire guide portion 34a along with the lead wire 32a of the primary winding 32, and is connected to the secondary side ground terminal 26 by means of the guide groove formed on the terminal unit 18. As will be obvious from the winding structure disclosed in the foregoing,

both terminals of the primary side winding 32 between the partitions 8 and 10 come to contact the ground side of low voltage of the secondary windings 39 and 41 and the difference with the voltage of the adjacent primary winding 35 and the voltage of the secondary windings 39 and 41 becomes smaller.

For this reason, the insulation pressure resistance structure between the primary winding 32 and the secondary windings 39 and 41 can be made of a simpler structure. Since the potential difference is small at the ground side of the primary winding 32 and the secondary windings 39 and 41, there will be no problem about the insulation pressure resistance even if both the windings are disposed in parallel through the common lead wire guide portion 34a. For reference, even if a plurality of lead wire guide portions are provided on the shelter 34 and a piece of the lead wire may be separately disposed on the lead wire guide portion. Numeral 42 denotes a core, and two pieces of E-shape cores are jointed to form the core, and an external portion is disposed at outside of the bobbin (insulator) 2, and an inside portion 42a of the core 42 is disposed in a cylindrical portion of the bobbin (insulator) 2. The foregoing wound-rotor transformer 44 constitutes one input/two outputs and is capable of driving two pieces of cold cathode fluorescent lamps with use of this transformer in a condition where there is no irregularity in the degree of brightness. In this case, the two pieces of lamps whose both terminals are connected to the high tension side of the secondary windings 39 and 41 whereby there is occurrence of

causing the difference in brightness at both ends of the lamps.

The above-noted one input/two output wound-rotor transformer 44 constitutes a series or parallel resonance circuit at primary side of this transformer, and is desirably drive with a self commutating circuit that generates commutation voltage at the primary side of the transformer. In this case, when the higher tension than the power source voltage is generated at the primary side of the transformer, a quantity of windings at the secondary side can be minimized, and as a result, two outputs can be materialized with the size equal to the wound-rotor transformer of conventional one input/one output. Moreover, the one input/two output wound rotor transformer concentrates the heat generation with the primary coil and the core in the central portion of the transformer but this heat generation producded in the centre portion of the transformer so that a balance of joint with the secondary winding is kept in favorable condition, and the transformer operates with efficiency. Like the conventional wound-rotor transformer of one input/one output type, when the heat generation concentrates at one side of the transformer, imbalance occurs in the joint of the primary winding and the secondary winding which blocks an efficient operation. In FIG. 6, numeral 120 denotes another embodiment of the shelter, and its cross section being a triangle.

An embodiment of driving the wound-rotor transformer 44 with the self commutating circuit that generates commutation voltage at the primary side of the wound-rotor transformer

will be described in the following by referring to FIG. 6. In FIG. 6, numerals 52, 54, 56, 58 denote switching elements consisting of FET, and commutation diodes 60, 62, 64, 66 are connected between source and drain of each switching element. At respective gates of the switching elements 52, 54, 56, 58, gate control circuits 68, 70, 72, 74 are connected, and among them, the gate control circuit 68 and 72 are connected to a PWM control circuit 76, and the gate control circuits 70 and 74 are connected to a logic circuit 78. The PWM control circuit 76 receives signals from a commutation smoothing circuit 80 that detects an electric current flowing in the lamps, and controls a conductance angle of the switching elements 52 and 56 so that a level of this signal becomes a set value to be given by the line 82. Numeral 44 denotes a wound-rotor transformer of one input/two output type fixed to a substrate (drawing is omitted), and two pieces of cold cathode fluorescent lamps 46 and 46 are connected in series, and each terminal of the fluorescent lamps 46, 46 is connected respectively to high tension terminal side of the secondary coils 39, 41 of the wound-rotor transformer 44. Each terminal of the secondary side windings 39, 41 is earthed respectively by means of resistors.

One resistor 48 constitutes an electric current detecting circuit, and is connected to a lamp open.lamp short detecting circuit 90 and a start compensating circuit 88. A phase detecting circuit 51 is connected to a mid point P of an EC series resonance circuit by means of the lead wire 27. A

logic circuit 78 is constructed in such a way that a signal produced for turning on and off of the switching elements on the basis of a resonance phase signal at primary side from a phase detecting circuit 51 connected to the lead wire 27, and transmits an on/off control signal to the gate control circuits 68 and 72 by means of a PWM control circuit 76, and transmits an on/off control signal to the gate control circuits 70 and 74. The phase detecting circuit 51 supplies a compensation phase signal delayed by 90 degrees from a phase voltage signal of the mid point P of the LC series resonance circuit to a logic circuit 78. This signal becomes an identical phase with electric current flowing in the LC series resonance circuit at the primary side. The electric current flowing in the series resonance circuit at primary side is such that even if a charge voltage of the capacitor C1 reaches DC power source voltage, the voltage of the primary side terminal of the transformer 44 gets lowered further beyond 0V after lapse of phase time of 90 degrees electrically, and furthermore becomes a maximum value of minus upon lapse of the phase time of 90 degrees.

At this time, the signal delayed by 90 degrees from this voltage becomes 0V so that the switching control signal is turned on and off by this timing. The logic circuit 78 outputs the switching control signals alternately in such a manner. The logic circuit 78 creates a light adjusting control signal on the basis of an output signal of a light adjusting control circuit 84 to which a light adjusting signal is inputted, and

with this light adjusting control signal, burst control of the on/off of the switching elements and control of switch on pulse width of the PWM control circuit 76 are achieved, and as a result, brightness of the lamps 46 and 46 is kept constant, and setting to an optional value from brightness zero to 100% can be performed according to the light adjusting signal. Moreover, the logic circuit 78 is connected to an overcurrent detecting circuit 86, and when overcurrent flows to the lamp 20, the logic circuit detects it and transmits the signal blocking the overcurrent to the PWM control circuit 76 to prevent the occurrence of such trouble.

The start compensating circuit 88 is connected to an energizing circuit of the lamp 48 and an electric current signal of the lamp 46 is inputted to the circuit. The start compensating circuit 88 transmits the start compensating signal to the phase detecting circuit 51 to cause the self commutating circuit to positively start when the power source is on and off. The phase detecting circuit 51 outputs the start signal for self commutation to the logic circuit 78 after receiving the start compensating signal. The start compensating circuit 88 is constructed in such a way that even if the electric current flows to the primary side of the transformer after sending the phase corrected signal from the phase detecting circuit 51 to the logic circuit 78 in a direction determined by the logic, the discharge of the lamp 46 does not always start. The start compensating circuit 88 is provided for compensation of start as described above. In

this case, in order to light up the lamp 46 positively, the start compensating circuit 88 judges about whether or not the lamp 46 is lighted upon detection of the electric current flowing in the light lamp 46, and when the lighting is not recognized, the start compensating signal is transmitted to the phase detecting circuit 51 until the lighting occurs.

The phase detecting circuit 51 outputs the start signal until lamp 46 lights up by receiving the start compensating signal to the phase detecting circuit 51. The light adjusting control circuit 84 generates a bust light signal of a predetermined period after comparison of the voltage of the the light adjusting signal input with the output voltage of the triangular wave oscillating circuit built therein. The entire logic signal is made subject to ON-Off according to a duty cycle of this signal and as a result, the brightness is capable of adjusting freely from the turn-off the light to full lights on, but the lamp 46 requires the start confirmation and the positive start for its period because the light adjusting is subject to ON-OFF in th period of the light adjusting signal. For this reason, the start compensating circuit 88, as described in the foregoing, transmits the start compensating signal to the phase detecting circuit 51 in the beginning in order to effect the positive start of lighting. The operation of the start compensation is described by referring to FIG. 9, the switching elements 52 and 58 are turned ON with a predetermined pulse width so that the electric current flows a direction of I1 when the power source is energized for the first time or the lamp is not

lighted on.

By the foregoing operation, the electric current flows to the capacitor (C1) and the primary winding of the transformer 44, and the signal is transmitted to the phase detecting circuit 51 by means of the lead wire 27, and the electric current flows alternately I2, I1,I2, I1, and the self commutating circuit starts the oscillation with the detected resonance frequency. The start compensating circuit 88 produces reset (start time) of the logic circuit 78. If the lamp 46 does not light up, the reset is tried again, and firstly, the initial start signal is transmitted to the logic circuit 78 through the phase detecting circuit 90. A lamp open.short detecting circuit 90 is connected to the secondary side of the wound-rotor transformer 10, and detects the voltage and the electric current at the secondary side. In the lamp open condition where the lamp 46 is not lighted on or the lamp 46 is not mounted or the lamp short where the wiring of the lamp is short, the signal is transmitted to the logic circuit 78 through the phase detecting circuit 51, and shuts out the control circuit consisting of the logic circuit 78, PWM control circuit 76 and gate control circuits 68, 70, 72, 74. The overcurrent detecting circuit 86 transmits the signal to the logic circuit 78 in the condition where the PWM control circuit 76 is in appropriate or the wiring of the lamp 20 is short and the like to shut off the control circuit.

In the foregoing construction, when the power source switch is turned on, the on signal form the PWM control circuit 76 and the logic circuit 78 is instantly supplied to any one of the

gate control circuits 68, 74 or 72, 70, the electric current flows to the primary side winding of the wound-rotor transformer 10 in a direction of I1 through the switching elements 52, 58 or in a direction of I2 through the switching elements 56, 54. By this operation, the self commutating circuit starts, and the resonance voltage is generated by the wound-rotor transformer 44. The frequency of the resonance voltage at the primary side of the wound-rotor transformer 44 is supplied to the phase detecting circuit 51 by the lead wire 27. The logic circuit 78 and PWM control circuit 76 drive the gate control circuits 68, 70, 72, 74 on the basis of the phase signal from the phase detecting circuit 51 to perform the on-off control of the switching elements 52, 54, 56 and 58.

The electric current flows alternately in direction of I1 and I2 by the on-off of the switching elements 52, 54, 56, 58, and the self commutating circuit performs self commutation with resonance frequency at the primary side of the wound-rotor transformer 10. To the electrodes of both terminals of two pieces of fluorescent lamps 46, 46, the high tension of the winding at the secondary side of the transformer is impressed whereby no irregularity in brightness occurs. When the wound-rotor transformer 44 is fixed to the substrate in a proper direction as shown in FIG. 7, secondary high tension terminals 24, 30 are disposed side by sandwiching the bobbin (insulator) 2 at the right side terminal units 16, 18 extending in a right angle direction relative to an axial direction of the bobbin (insulator) 2, and at the left side, the ground terminals 20,

26 and the primary input terminals 22, 28 are disposed side by side by sandwiching the bobbin (insulator) 2. For this reason, the lamps 46, 46 are connected to the wound-rotor transformer 44 by means of a connector 128 simply with a shortest possible distance, and the simple construction is arranged for the connecting wiring between the transformer 44 and the lamps 4, 46 and the connecting wiring with the self commutating circuit.

Moreover, as will be obvious from FIG. 7, as the high tension terminal at the right side of the wound-rotor transformer and the low tension terminal at the left side thereof, edge face distance between the high tension side and the low tension side of the transformer can be assured widely whereby a stable operation of the transformer and its miniaturization can be obtained.

For reference, either of the embodiments is such that the resonance frequency at the primary side of the wound-rotor transformer is produced through the lead wire from the primary side of the wound-rotor transformer, but the invention is not limited in particular to this construction, and another construction may be such that the primary side resonance frequency is detected by the frequency analyzing circuit from the resonance frequency at the secondary side of the wound-rotor transformer, and the logic circuit 78 or the PWM control circuit 76 and the like can be operated by this detection signal.

The present embodiment, as described in the foregoing, is able to obtain the resonance voltage higher than the input

power source voltage at the primary side of the wound-rotor transformer so that number of windings at the secondary side of the wound-rotor transformer can be reduced, and its design can be miniaturized. For this reason, the wound-rotor transformer to be used in the present invention is the size almost identical with that of the wound-rotor transformer of normal one input-one output type, and it is possible to prepare the one input-two output type wound rotor transformer.

Moreover, another embodiment of the wound-rotor transformer is described in the following by referring to FIG. 8.

In the drawing, numeral 130 denotes a bobbin (insulator), and is inserted into one of parallel portion of the core 132. The core 132 is constructed in shape by joining two pieces of core of shape. At both ends of the bobbin (insulator) 130, terminal units 134, 136 are mounted and on each terminal unit 134, 136, secondary side high tension terminals 38, 40, secondary side ground terminals 142, 144, primary side input terminals 146, 148 are provided. At the center of the bobbin (insulator), a primary winding 150 is disposed, and both terminals of the primary winding 150 are connected to the primary input terminals 146, 148 as shown in the drawing through the lead wire. Secondary windings 156, 158 are disposed at both terminals of the primary input winding 150 by means of the partitions 152, 154 for insulation and pressure resistance in order to assure a surface along distance between the windings. The winding start ends of the secondary windings 156, 158 are connected to the primary high tension

terminals 13 8, 140 by means of the lead wire, and the winding end terminal is connected to the ground terminals 142, 144 as shown in the drawing by means of the lead wires respectively.

With the foregoing construction, a unit of one input with plural outputs can be obtained by a simple construction. Also, the other parallel portion of the core 132 can be similarly constructed, and in this case, the primary sides are connected in series or parallel to form one input and four outputs.

Moreover, in the foregoing construction shown in FIG. 8, as shown in FIG. 9, terminal units 152, 164 serving double for partition are provided at a middle of the bobbin (insulator) 160, and terminal units 166, 168 are provided at both ends of the bobbin (insulator) 160. and both terminals of the primary winding 150 are connected to the primary input terminals 170, 172 by means of the lead wire, and each winding start end of the secondary windings 156, 158 is connected to the secondary side high tension terminals 174, 176 by means of the lead wire, and each winding end terminal of the secondary windings 156, 158 may be connected to ground terminals 178, 180 by means of the lead wire.

Another embodiment of the wound-rotor transformer will be described in the following by referring to FIG. 1 and FIG. 11.

Numeral 182 denotes a core, and constitutes a □ shape core by joining two pieces of ⊐ shape core. To one part of parallel portion of the core 182, a bobbin for primary (insulator) 184 is inserted and disposed. At the center of the primary bobbin (insulator) 184, a terminal unit 186 is

mounted, and primary input terminals 188, 190 are provided on the terminal unit 186. On the bobbin (insulator) 184, a primary winding 192 is mounted, and at both terminals of the primary winding 192, primary input terminals 188, 190 are connected by means of the lead wire. At the outside of the primary bobbin (insulator) 184, a pair of secondary bobbins (insulator) 192, 194 are inserted and disposed which are positioned at both sides of the terminal unit 186. A partition 196 at each end of a pair of the secondary bobbins (insulator) 192, 194 abuts both side surfaces of the terminal unit 186. In FIG. 10, the partition 196 of the secondary bobbins (insulator) 192, 194 is not shown in the drawing for avoiding a complication of drawings. Secondary windings 198, 200 are wound on the secondary bobbins (insulator) 192, 194 by two pieces of wires a, b that are duplex winding. The winding start ends of the secondary windings 198, 200 that are of the duplex wires are connected to a secondary high tension terminals 206, 208, 210, 212 provided on the respective terminal units 202, 204 of the secondary bobbins (insulator) 192, 194 by means of the lead wires, and the winding ends are connected to ground terminals 214, 216 by means of the lead wires.

In the foregoing construction, a relationship of the primary winding 192 and the secondary windings 198, 200 is such that in the double layer structure of the bobbin (insulator), the secondary windings 198 and 200 are disposed at both sides of the primary winding, whereby a multiple outputs

can be constructed by a simple structure. In this embodiment, the high tension might be applied to duplex parallel lines forming the secondary windings, but this high tension is of mutually identical electric potential so that there is no chance of causing a shortcircuit or leakage of electric current in the parallel secondary windings. Moreover, the other parallel portion 182a of the core 182 can be made in the similar construction and in case of making this vertically symmetrical structure, one input can be made by connecting the primary side in series or parallel to produce 8 outputs. When a number of windings is set to be 3 pieces or 4 pieces, multiple outputs can be materialized. For reference, the wound-rotor transformers of the embodiment shown in FIG. 8 to FIG. 11 are operated by the self commutating circuit shown in FIG. 6.

Another embodiment of the wound-rotor transformer in which secondary windings are disposed at both sides of the winding of the primary input will be described in the following.

In FIG. 12, numeral 222 denotes a bobbin (insulator), and a primary winding 224 is mounted on its external peripheral portion. Holes 226, 228 that penetrate in a thickness direction are formed on an inside diameter of the bobbin 22, and parallel portions 230a, 230b of the core 230 of U-shape are inserted in the holes 226, 228. The inside diameter portions of the bobbins 236, 238 mounted with the secondary windings 232, 234 are inserted into the parallel portions 230a, 230b. Numeral 240 denotes a bar like core coupled to an open end of the U-shape

core, which is designed to make a magnetic circuit formed by the core to be a closed loop. Terminal units 242, 244 are mounted on both sides of the core 230, and on one terminal unit 242, secondary ground terminals 246, 248 and primary input terminals 250, 252 are provided, and on the other terminal unit 244, secondary high tension terminals 254, 256 are provided. Both ends of the primary winding 224 are connected to the corresponding primary input terminals 250, 252, and the high tension sides of the secondary windings 232, 234 are connected to the corresponding secondary high tension terminals 254, 256, and each ground side is connected to the corresponding secondary ground terminals 246, 248.

The foregoing primary winding 224 is constructed as shown in FIG. 12 that its inside diameter portion is spanned over a part of the parallel portions 230a, 230b of the core 230 and a part of a vertical portion of the core 230. For reference, as a method of transforming the magnetic circuit of the core 230 to a closed loop, an arrangement can be made to cover the core 230 with the core 258 by using the core 258 shown in FIG. 13 (f), and to abut the end edge portion 258a of one part against the open ends of the parallel portions 230a, 230b of the core 230, and to abut the other end edge portion 258b against the vertical portion of the core 230.

By preparing the foregoing construction, it becomes possible to construct a small size one input-two outputs type wound-rotor transformer by arranging the primary winding in the middle and the secondary windings at its both sides.

The foregoing transformer 260 is provided for service by being connected to the self commutating circuit of primary series resonance type similar to the transformer shown in FIG. 6. Moreover, multi-output type wound-rotor transformer can be provided by making the secondary windings 232, 234 of the transformer 260 to become a multi-output type wound-core transformer.

An embodiment that has materialized a double layer structure of the primary winding and the secondary winding with use of an insulation film will be described in the following by referring to FIG. 14.

Numeral 262 denotes a core formed by joining a pair of E-shaped cores symmetrically, and a bobbin 264 is mounted on an inside portion of the core, and a primary winding 266 is wound on the bobbin 264. An insulation film 268 covers the primary winding 266. Secondary windings 270, 272 are wound on the insulation film 268 which are positioned at both right and left sides of the primary winding 266. 400-1000 turns of each secondary winding 270 and 270 are applied and the insulation film (drawing is omitted) is disposed on portions where windings are mutually duplicated. Between the secondary windings 270 and 272, and over the secondary windings 270 and 272, the partition (drawing is omitted) for insulation and pressure resistance is properly provided on the secondary windings 270 and 272. Both terminals of the primary winding are connected to the primary input terminals 278, 280 of the terminal units 274, 276 provided at both sides of the core 262.

One of the secondary windings 270, 272 is respectively connected to secondary ground terminals 282, 284, and the other of the secondary windings 270 and 272 are connected to the secondary high tension terminals 286, 288.

A wound-core transformer with secondary windings structure can be provided by forming the foregoing construction to obtain one input-two output type transformer suitable for small size transformer wherein the primary winding is disposed in its center and the secondary windings are disposed at its both sides.

The foregoing transformer can be used by being connected to a self commutating circuit of primary series resonance type similar to the transformer shown in FIG. 6. Moreover, the secondary windings 270, 272 of the transformer are arranged to be a parallel winding as shown in FIG. 11 whereby a multi-output type wound-rotor transformer can be produced.

In the embodiment as shown in FIG. 6, a resonance capacitor C1 is serially connected to a terminal of the primary winding of the output transformer 44, and a series commutating circuit is formed at the primary side of the output transformer 44, but this invention is not particularly limited to this construction. For example, as shown in FIG. 15, in the output transformer shown in each of the foregoing embodiments wherein the primary winding is disposed in the center and the secondary windings are disposed at its both sides, the primary winding is wound, for example, 11 turns each to form taps, and the resonance capacitor C1 is connect d in series as shown in FIG.

15 to form an output transformer 44'. The construction of the primary side series commutating circuit LC can be made a symmetry with the capacitor C1 being the center, and by this symmetry construction, the output transformer 44' can be efficiently driven. The lead wire 27 for detection of the voltage phase signal at the primary side is connected to a connecting point of the capacitor C1 and the mid point tap of the primary side winding as shown in the drawing. Moreover, the capacitor C1 can be formed by mutually connecting two pieces of capacitors, and the lead wire 27 may be connected to the connecting point of the capacitors. When the foregoing construction is formed, symmetry at the primary side of the output transformer can be made as a perfect one. As to the core of the output transformer used in the foregoing embodiment, ferrite core having insulating properties can be used. In case of using the insulating core, the winding can be directly mounted on the core without using the bobbin or the insulating film.
